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Altitude for PP/Relay Orbit Lifetime Status

- Error in code for long orbit propagation of mean elements (POLOP) corrected
  - effect of error was to underestimate drag (overestimate lifetime)
  - error discovered by run of slower high precision code (POHOP) for verification of POLOP runs
    - POLOP speed necessary for “trinomial” analysis to minimize altitude (POHOP for refinement & verification of final results)
- An overly conservative choice of the long-term average atmospheric density at the model reference altitude from the range of values available in the Mars Observer model was reduced by a factor of two
  - effect of previous high value was to overestimate drag
- Shorter Relay Phase requires longer (uncontrolled) orbital lifetime and therefore higher altitude (46.5 vs. 44 years)

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- Best values (POHOP) : 427 km (46.5 yr. b/l) & 419 km (44 yr.)
- Pertinent Results
  - POLOP overestimates drag to yield a required altitude about 4 km higher than the slower more accurate POHOP
  - the extra 2.5 years of lifetime required for the short Relay Phase (b/l) costs an additional 8 km
  - a density factor of 2 (or a ballistic parameter factor of 2 in the opposite sense) costs about 32 km
- Ongoing Efforts
  - S. Bougher (U. Arizona) will provide new best long-term average density at reference altitude and scale height
    - early response is density may be slightly lower

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- Outstanding Issues of Analysis
  - what is acceptable conservatism in choice of long-term average density and the magnitude of temporal variability?
  - scale height variation with altitude (both the gradual variation at high altitudes early in lifetime and the abrupt variation at lower atmospheric boundaries)
  - what is required conservatism in meeting PP requirement?

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- Other Approaches
  - as part of S/C shutdown (at **real** end of mission), reconfigure for minimum worst-case (vs. attitude) drag area or for minimum average (over attitude) drag area, with tumbling ensured
    - essentially turn solar panels normal to each other and normal to largest bus area (also consider HGA); attain ~11 m^2
    - since current ballistic coefficient corresponds to 17.02 m^2, could save about a factor of 1.5 on density or ~20 km in alt.
- Recommendations
  - plan for 427 km (b/l Relay Phase) (use Bougher results for margin)
  - LMA study terminal reconfiguration and ballistic coefficient
  - POHOP to verify margin at 427 km with new ballistic coefficient